I S S U A N C E  T R A N S M I T T A L
S H E E T

N A S A
National Aeronautics and
Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

| Issuance Number: MMI 8080.5C | Date: April 3, 1990 |
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Material Transmitted:

1. Management Instruction MMI 8080.5C, "Policy for Certification/Qualification of Flight Hardware and Program Critical Ground Support Equipment."

2. This instruction has been revised to:

   a. Update organizational references;

   b. Clarify responsibilities of Safety, Reliability, Maintainability, and Quality Assurance (SRM&QA) and those of the other MSFC organizations involved; and

   c. Make editorial changes to improve overall clarity of the instruction.

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Filing Instructions:
Remove MMI 8080.5B and change 1 thereto, and replace with MMI 8080.5C.

M A N A G E M E N T
I N S T R U C T I O N

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| Originating Organization: CQ01 | Effective Date: April 3, 1990 | MMI: 8080.5C |
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Subject: POLICY FOR CERTIFICATION/QUALIFICATION OF FLIGHT HARDWARE AND PROGRAM CRITICAL GROUND SUPPORT EQUIPMENT

1. PURPOSE

This issuance establishes the MSFC policy for certification of flight hardware and program critical ground support equipment.

2. APPLICABILITY

This issuance applies to all MSFC organizations responsible for design and certification of flight hardware and program critical ground support equipment.

3. REFERENCES (Only applicable parts of most recent editions apply.)

a. MMI 8030.2, "Policy on MSFC Payloads."

b. NHB 5300.4(1B), "Quality Provisions for Aeronautical and Space System Contractors."

c. NHB 5300.4(1D-2), "Safety, Reliability, Maintainability and Quality Provisions for the Space Shuttle Program."

4. POLICY

Certification of flight hardware and program critical ground support equipment shall be accomplished using efficient and effective methods in achieving confidence that items meet the designed mission requirements. (See Attachment B for certification levels and methods.)

5. DEFINITIONS

Definitions are outlined in Attachment A.

6. GENERAL PROVISIONS

a. Certification programs shall be established based on criticality, design requirements, environmental criteria, and structured to closely simulate the anticipated mission duty cycle. Storage, handling, transportation, prelaunch, flight, and postflight functional performance and environmental requirements shall be included. Maintainability, storage/operational life, stress analysis, design safety factors, and redundancy features shall also be considered in the certification program. Design construction standards, material selection requirements, reliability and safety statements, manufacturing inspections or tests, and other typical requirements should not be written into the certification plan since these types of requirements are verified by design reviews, manufacturing inspections, or final acceptance testing.

b. The MSFC Project Offices are responsible for the development and issuance of Certification Plans to define specific requirements and responsibilities for implementing certification of flight items and program critical ground support equipment.

c. Selecting items for certification is the responsibility of the organization with the design development responsibility with approval of the Project Manager. The following criteria shall be used for determining items requiring certification:

(1) As a minimum, all items identified as criticality 1, 1R, 2, and 2R (also 2P and 2PR for Payloads) by the Failure Mode and Effects Analysis (FMEA) shall be certified for flight as an entity or as part of a higher assembly.

(2) Payload items shall be certified according to payload classifications depicted in MMI 8030.2, "Policy on MSFC Payloads." Payload certification shall be as follows:

(a) Class A payloads shall be subject to the certification requirements of this instruction.

(b) Class B, C, and D payload certification requirements shall be defined by the Payload Project Office using this instruction as a guide, and shall be documented in the Project Plan as required by MMI 8030.2, paragraphs 3.d. and e. Class B, C, and D payloads are required to meet this instruction's certification requirements only to the extent noted in the Project Plan.

(3) Program critical ground support equipment will be selected for certification based on expected environmental conditions, operational constraints, or hardware failure which could cause loss or damage to vehicle systems and/or personnel. Testing will be performed to the extent necessary to qualify the critical functions.

d. The Failure Mode and Effects Analysis (FMEA) and Safety Hazards Analysis shall be used as a guide for selection of critical design features and parameters to be certified.

Note: Deviation from these general requirements may be authorized (in accordance with MM 1410.2) when programmatic circumstances warrant.

7. RESPONSIBILITIES AND PROCEDURES

(See Attachment C.)

8. FORMS AND REPORTS

A Certificate of Qualification (COQ), MSFC Form 511 or equivalent, shall be used to document and approve certification of flight hardware and program critical ground support equipment. A COQ shall be prepared by the responsible design organization and submitted to the MSFC SRM&QA Office for coordination, review, and approval.

9. CANCELLATION

MMI 8080.5B, "Policy for Qualification of Flight Hardware and Ground Support Equipment," dated February 10, 1983, and Change 1 thereto.

(Orig s/by)
T. J. Lee
Director

Attachments:

A. Definitions
B. Certification levels and Methods
C. Responsibilities and Procedures

Distribution: SDL 3

DEFINITIONS

Certification: The process of reviewing, assessing, and formally declaring the adequacy of verification data used to establish qualification status.

Qualification: The process of conducting formal test and/or analysis on flight configured hardware or program critical ground support equipment to demonstrate that adequate margins exist to assure that specification requirements are met and that the hardware satisfies design, performance, and environmental requirements for its intended use.

Flight Hardware: Hardware assigned for flight.

Program Critical Ground Support Equipment: Those items of ground support equipment whose malfunction could result in personnel injury or significant damage to flight hardware.

Certificates of Qualification (COQ): A form (MSFC 511 or equivalent) used to list the configuration of the hardware and documentation (test reports, analysis reports, failure analysis reports, discrepancy reports, etc.) required to verify that the flight hardware or program critical ground support equipment is qualified for its intended use. The COQ is used to document the hardware certification approval.

Criticality Categories: Classifications used to identify and differentiate failures and their impacts to flight and ground hardware items during their planned use.

Items: As used in this Instruction, any self contained element of flight hardware or program critical ground support equipment, from component and "black box" assembly level up to, and including, the end item.

Certification Plan: A document prepared to depict certification requirements and responsibilities for implementing certification of flight items and program critical ground support equipment.

# CERTIFICATION LEVELS AND METHODS

1. Certification shall be performed at the component and/or subsystem level that can be efficiently adapted to a certification program and likewise maintain visibility of configuration changes that require recertification.

2. Methods of certification shall include qualification test, similarity, analysis, or combinations of these methods. Supporting rationale shall be provided for items certified by similarity or analysis.

3. Qualification tests shall be conducted using the following criteria to maintain strict test controls:

   a. The number of qualification test items normally will be sufficient to determine item-to-item variations and detect a range of operating characteristics. The following criteria shall be used for determining the number of qualification test units:

      (1) FMEA Criticality Rating
      (2) Design complexity
      (3) Manufacturing difficulty
      (4) Inspectability of the design
      (5) Knowledge of the design gathered by development activities and previous histories

   b. Configuration - Qualification test hardware/software shall be of the same configuration as the flight hardware/software and fabricated/produced by the same manufacturer using identical processes, materials, and quality control procedures, unless differences are formally documented and approved by the Project Manager.

   c. Procedures - Qualification Test Procedures (QTP's) delineating the full range of requirements, test methods, and pass-fail criteria must be used in conduct of tests.

d. Sequence - Qualification tests should include natural and induced environmental testing in a sequence to simulate the anticipated mission duty cycle environmental and performance requirements. For example, a mission duty cycle may consist of transportation/storage, prelaunch (on-pad), flight, and postflight environmental and functional requirements. An item that functions during a mission environment shall be tested to an abbreviated functional test during the environmental test that includes the functions required of the item during the mission. If an item is nonoperating during an environment, an abbreviated post-environmental functional test shall be performed to assure that the item was not adversely affected by the environmental exposure. A complete functional test conforming to acceptance criteria must be performed at the beginning and after completion of the qualification series. The operating time/cycle, environmental exposure duration, and maintainability requirements must be factored into the qualification test sequences. Multimission (reused items) should be sequenced according to the expected usage and include the required refurbishment activities.

e. Special Qualification Test - Structural items and pressure vessels shall be subjected to pressure and load testing to demonstrate structural adequacy and safety factors. Age/storage life, special testing for pyrotechnic devices, lightning, aerothermal (wind tunnel), and electromagnetic compatibility tests may also be required.

f. Nonconformance/Failure Reporting - Nonconformances and failures encountered during qualification testing shall be reported and positive corrective action made in accordance with NHB 5300.4 (1D-2), or other comparable program quality requirements. Adjusting, tuning, or rework of test items during qualification test is not permitted. Adjusting or tuning may be made if it is normal operational flight procedure or refurbishment for reflight procedure.

g. Retest - Retest required after a qualification test failure has been corrected will depend upon severity of the failure and significance of the corrective action taken. Retest dispositions and responsibilities shall be stated in the certification plan for each MSFC managed project.

h. Qualification Test Reports - The qualification test reports shall be prepared to document results of all testing, and shall include the following items:

(1) Identification of test articles shall include part number, revision, and serial number. Difference in flight versus qualification configuration shall be detailed.

(2) A narrative summary and conclusive statement of the qualification test results shall be included, and comparison of results to test specifications shall be made. Comparison of prequalification and postqualification test data shall be made, and evidence of wear will be assessed to ensure operational acceptability.

(3) Functional test data and environmental measurements (temperature, vibration curves, etc.)shall be included.

(4) Test support equipment (power supplies, measuring instruments, environmental chambers, vibration equipment, etc.) shall be listed with calibration data.

(5) Test anomalies and test article failure reports shall be included.

i. Qualification test Item Control - Normally, qualification test items are not to be used for flight and shall be permanently marked "Not For Flight Use" to prevent inadvertent use. However, for Class B, C, and D payload applications, as defined by MMI 8030.2, the Payload Projects Office may authorize qualification tests to be performed on flight items (e.g.,protoflight units) as depicted in the Certification Plan. Qualification tests on flight items should be established at sufficient levels and durations to qualify the design performance without degrading the flight use of the item.

4. Certification by similarity may be used in lieu of tests where it can be shown that the item is similar or identical in design, manufacturing process, and quality control to another item that has been previously certified to equal or more stringent criteria. Delta qualification tests should be concentrated on the areas of new or increased requirements. Certification by similarity may be achieved provided that all of the following conditions are met:

a. Engineering evaluations reveal that design configuration and performance differences between the item being certified and the similar item are insignificant.

b. The previously certified similar item was designed and qualified for equal or higher environmental stress levels and time durations than those required for the item to be certified.

c. The item being certified is built by the same manufacturer as the similar item using the same manufacturing processes and quality control procedures. Exceptions to this requirement may be granted on a case-by-case basis by approval of the MSFC Project Office with concurrence of the Science and Engineering Directorate and the Safety, Reliability, Maintainability, and Quality Assurance Office.

d. Documentation is provided to substantiate certification by similarity. A Similarity Analysis Report detailing design and environmental comparisons between the certification item and the similar item must be submitted for MSFC review and approval. Supporting documentation such as specifications, drawings, qualification test procedures, and qualification test reports should also be provided.

Exclusions:

Certification by similarity of items from different manufacturers is not allowed for criticality 1 or 1R items.

Certification by similarity shall not be made to another article that has been certified by similarity.

5. Certification by analysis can be used if it can be shown by accepted analytical techniques (math models, stress analysis, thermal analysis, etc.) that a hardware item meets the design and performance requirements. Certification by analysis must be supported by MSFC approved analysis reports.

6. Items certified by similarity or analysis must undergo an independent assessment by a technically qualified person or group other than the initiating persons or group. Review and approval by the appropriate MSFC organization is required and will serve as the second assessment of contractor prepared analyses.

7. Qualification test reports, similarity reports, analysis reports, and other documentation supporting certification must accompany the submittal of the COQ. Documentation shall be submitted 30 days prior to use to allow for a thorough engineering and technical review by MSFC Engineering and SRM&QA Office.

8. Recertification of an item shall be required under the following conditions:

a. Design or manufacturing process changes have been made which significantly affect the function or reliability;

b. Data indicates that a more severe environment or operating conditions exist for which the item was not originally certified;

c. The manufacturing source has been changed; or

d. Significant or recurrent failures occur during testing or operational use of an item.

A COQ shall be withdrawn from "approved" status when one or more of the above conditions occur.

RESPONSIBILITIES AND PROCEDURES

1. MSFC Project Office will:

   a. Manage the implementation of this instruction to assure proper accomplishment of the overall hardware certification/qualification objectives in the most efficient and cost effective manner.

   b. Direct the development and approval of Certification Plans.

   c. Direct certification planning to the responsible MSFC organization or contractor for implementation to the requirements of this MMI.

   d. Provide programming and scheduling to assure timely completion of certification activities.

2. Science and Engineering Directorate will:

   a. Ensure that this instruction is implemented within the responsible elements of S&E in a manner that is responsive to program requirements and constraints.

   b. Manage the efforts of the various S&E organizational elements to ensure that certifications are properly conducted and documented.

   c. Support the Project Manager as required to establish Certification Plans and to assure proper technical execution of the certification program.

   d. Assess contractor similarity and analysis reports to fulfill the requirements of Attachment B, Paragraph 6, of this instruction.

   e. Concur in COQ's.

3. Safety, Reliability, Maintainability and Quality Assurance (SRM&QA) Office will:

   a. Review the program requirements flowdown from the appropriate management level to assure that certification/qualification requirements are identified for all items which are to be certified. Assure that MSFC Science and Engineering elements have approved lower level requirements, (specifications, drawings, certification plans, verification matrices, qualification test procedures, etc.).

   b. Evaluate certification planning for each program to assure that all program requirements are included, and are being certified by an approved method.

c. Monitor and verify qualification test activities to assure compliance with requirements and validate test results.

d. Provide a coordinated review of COQ's and supporting documentation (qualification test, similarity and analysis reports) through all cognizant MSFC organizations, and obtain appropriate signature approval of COQ's.

e. Perform a review of the COQ's and supporting documentation to verify, as a minimum, the following:

(1) COQ's and supporting documents are complete and legible.

(2) Test and analysis were performed to approved procedures.

(3) Test item configuration is flight equivalent or approved for test.

(4) All data is acceptable and requirements have been met.

(5) Test failures and anomalies were documented and dispositioned, including satisfactory retest.

(6) Test equipment and facilities were certified and calibrated.

(7) A second and independent assessment was performed and provided for similarity and analysis reports per Attachment B, paragraph 6, of this instruction.

f. Establish and maintain record files for COQ's and supporting documentation.

g. Withdraw Certificates of Qualification (COQ's) from "approved" status in accordance with Attachment B, paragraph 8, of this document.

h. Concur in COQ's.

4. Institutional and Program Support Directorate will:

a. Ensure that necessary requirements are contractually implemented based upon inputs from the Program/Project Office.

b. Provide support as required to the Project Office, MSFC Science and Engineering, and SRM&QA Office in the conduct of the certification program.